

Effect of a Second, Parallel Capacitor on the Performance of a Pulse Inductive Plasma Thruster

Kurt A. Polzin[‡]

Joseph V. Balla*

NASA-Marshall Space Flight Center, Huntsville, AL, 35812

The Ohio State University, Columbus, OH 43210

Pulsed inductive plasma accelerators are electrodeless space propulsion devices where a capacitor is charged to an initial voltage and is then discharged through an inductive coil that couples energy into the propellant, ionizing and accelerating it to produce thrust. A model that employs a set of circuit equations (as illustrated in Fig. 1a) coupled to a one-dimensional momentum equation has been previously used by Lovberg and Dailey [1] and Polzin *et al.* [2-4] to model the plasma acceleration process in pulsed inductive thrusters.

In this paper an extra capacitor, inductor, and resistor are added to the system in the manner illustrated in the schematic shown in Fig. 1b. If the second capacitor has a smaller value than the initially charged capacitor, it can serve to increase the current rise rate through the inductive coil. Increasing the current rise rate should serve to better ionize the propellant.

The equation of motion is solved to find the effect of an increased current rise rate on the acceleration process. We examine the tradeoffs between enhancing the breakdown process (increasing current rise rate) and altering the plasma acceleration process. These results provide insight into the performance of modified circuits in an inductive thruster, revealing how this design permutation can affect an inductive thruster's performance.

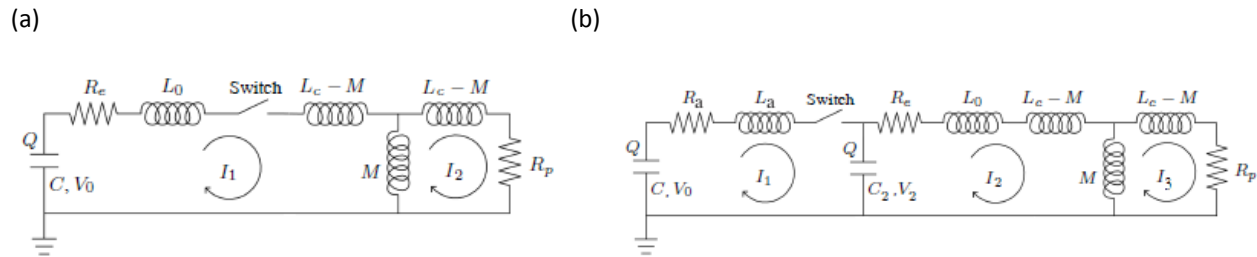


Fig. 1.(a) Schematic of a lumped-element circuit model of a pulsed inductive accelerator(from Ref. [1]). (b) Schematic of a lumped-element circuit model of a pulsed inductive accelerator with a second capacitor added to the system.

References

- [1] R. H. Lovberg and C. L. Dailey, "Large inductive thruster performance measurement," *AIAA J.*, vol. 20, no. 7, pp. 971-977, Jul. 1982.
- [2] K. A. Polzin and E. Y. Choueiri, "Performance Optimization criteria for pulsed inductive plasma acceleration," *IEEE Trans. Plasma Sci.*, vol. 34, no. 3, pp. 945-953, Jun. 2006.
- [3] K. A. Polzin and J.P. Reneau, "Scaling and Systems Considerations in Pulsed Inductive Plasma Thrusters," *IEEE Trans. Plasma Sci.*, vol. 37, no. 2, pp. 359-364, Feb. 2009.

[‡] Propulsion Research Engineer, Propulsion Research and Technology Applications Branch, Propulsion Systems Department. Senior Member AIAA.

*Undergraduate Student, Aerospace Engineering Department, Student Member AIAA.

[4] K. A. Polzin, "Faraday accelerator with radio-frequency assisted discharge," Ph.D. dissertation, Princeton Univ., Princeton, NJ, 2006. Thesis No. 3147-T.

✉ Propulsion Research Engineer, Propulsion Research and Technology Applications Branch, Propulsion Systems Department.
Senior Member AIAA.

*Undergraduate Student, Aerospace Engineering Department, Student Member AIAA.